Beaufort Sea Play 11: Brookian Unstructured Western Turbidite

Geological Assessment:
GRASP UAI: (AAAAABAS)
Play Area: 3,048 square miles
Play Water Depth Range: 5 – 800 feet
Play Depth Range: 3000 – 23000 feet
Play Exploration Chance: 0.3840

Play 11, Brookian Unstructured Western Turbidites, Beaufort Sea OCS Planning Area, 2006 Assessment, Undiscovered Technically-Recoverable Oil & Gas

Resource Commodity (Units)	Resources *		
	F95	**Mean**	**F05**
BOE (Mmboe)	0	218	777
Total Gas (Tcfg)	0.000	0.324	1.165
Total Liquids (Mmbo)	0	161	569
Free Gas** (Tcfg)	0.000	0.217	0.778
Solution Gas (Tcfg)	0.000	0.107	0.387
Oil (Mmbo)	0	151	536
Condensate (Mmbc)	0	10	33

Assessment Results as of November 2005

* Risked, Technically-Recoverable

** Free Gas Includes Gas Cap and Non-Associated Gas

F95 = 95% chance that resources will equal or exceed the given quantity

F05 = 5% chance that resources will equal or exceed the given quantity

BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Mmb = millions of barrels

Tcf = trillions of cubic feet

Table 1

Play 11, the "Brookian Unstructured Western Turbidite" play, contains less than 2% of the Beaufort Sea Province hydrocarbon endowment (218 Mmbo mean BOE). The overall assessment results for play 11 are shown in table 1. Liquid hydrocarbons are likely to comprise 74% of the play's resources. Table 5 reports the detailed assessment results by commodity for play 11.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Beaufort Sea play 11. Table 4 reports the risk model used for play 11. The location of play 11 is shown in figure 1.

Play 11 occurs within the Lower Cretaceous prodelta shales and turbidite sandstones of the Torok Formation (lower part of the Brookian sequence). It mostly underlies the Brookian Unstructured Western Topset play (play 9). Expected reservoirs include turbidite sands deposited in submarine fan environments. Sandstones are likely to offer only poor reservoir quality due to the fine-grained and mud-rich nature of the sediments fed to the shelf break by the Nanushuk delta system. The Torok Formation, Pebble Shale, Kingak shale and Shublik Formation all form potential source rocks for charging reservoirs in this play. The Kingak shale in this area may be oil prone, but probably reaches sufficient thermal maturity only in rift grabens with expanded sedimentary thicknesses. Prospects are primarily stratigraphic traps formed by sand mounds within a shale sequence. The Phoenix well tested heavy oil in the Torok Formation and the Mukluk well had several Torok Formation oil shows.

As in the other Western Brookian plays, reservoir quality is the primary risk element for this play. The presence of closure and adequate migration are also risk factors.

A maximum of 12 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 11.

These pools range in mean conditional (un-risked) recoverable volumes from 4 Mmboe (pool rank 12) to 193 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 15 Mmboe (F95) to 668 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 11.

ranges from 16 to 32 Mmboe. The largest pool among the 29,469 simulation pools falls within pool size class 17, which ranges in size from 2,048 to 4,096 Mmboe.

Play 11, Brookian Unstructured Western Turbidites, Beaufort Sea OCS Planning Area, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools			
Assessment Results as of November 2005			
Pool Rank	**BOE Resources ***		
	F95	**Mean**	**F05**
1	15	193	668
2	5	58	178
3	3	29	85
4	1.68	18	52
5	1.17	13	36
6	0.89	10	27
7	0.73	8	22
8	0.60	6.5	18
9	0.50	5.5	15
10	0.43	4.8	13
* Conditional, Technically-Recoverable, Millions of Barrels Energy-Equivalent (Mmboe), from "PSRK.out" file			
F95 = 95% chance that resources will equal or exceed the given quantity			
F05 = 5% chance that resources will equal or exceed the given quantity			
BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas			

Table 2

Table 6 reports statistics for the simulation pools developed in the *GRASP* computer model for play 11. In the computer simulation for the play, a total of 29,469 "simulation pools" were sampled for size. These simulation pools can be grouped according to the USGS size class system in which sizes double with each successive class. Pool size class 10 contains the largest share (5,886, or 20%) of simulation pools (conditional, technically recoverable BOE resources) for play 11. Pool size class 10

GRASP Play Data Form (Minerals Management Service-Alaska Regional Office)

Basin: Beaufort
Play Number: 11
Play UAI Number: AAAAABAS

Assessor: Johnson/Scherr
Play Name: Brookian Unstructured Western Turbidite

Date: 10/14/2005

Play Area: mi^2 (million acres) 3048 (1950.8)
Reservoir Thermal Maturity: % Ro

Play Depth Range: feet 3000 9,000 23000
Expected Oil Gravity: ^{O} API 25
Play Water Depth Range: feet 5 60 800

POOLS Module (Volumes of Pools, Acre-Feet)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Prospect Area (acres)-Model Input	142	1072		2752	5200		10208			26211		40000	60000
Prospect Area (acres)-Model Output													
Fill Fraction (Fraction of Area Filled)	0.1	0.14		0.29	0.5		0.76			0.95		0.99	1
Productive Area of Pool (acres)	14.94588	339.48788	531.5544	1108.458	2527.138	5354.139/ 8713.669	5594.699	8503.049	11659.32	17020.6055			58949.64
Pay Thickness (feet)	7.0	21.9	26.6	36.9	53.0	61.486/36.492	76.2	92.6	105.6	128.4	160.0	185.3	392.0

MPRO Module (Numbers of Pools)

Play Level Chance	0.8	Prospect Level Chance	0.48	Exploration Chance	0.384

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.8	Presence of Closure	
		Presence of Reservoir Facies	0.6
		Adequate Migration	0.8

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	4.00	4.70	5.10	5.95	7.00	7.68/1.72	8.20	9.00	9.40	10.30	11.30	11.90	12.00
Numbers of Pools in Play			0@F79.1	1	3	2.95/2.06	4	5	6	6	7	8	12

Minimum Number of Pools	0	Mean Number of Pools	2.95	Maximum Number of Pools	12

POOLS/PSRK/PSUM Modules (Play Resources)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Oil Recovery Factor (bbl/acre-foot)	42.0	97.5	113.0	144.5	190.0	206.636 / 88.921	249.8	289.2	319.5	370.2	436.9	488.0	858.0
Gas Recovery Factor (Mcfg/acre-foot)	122	343	411	557	781	887.76/483.429	1094	1311	1483	1778	2181	2500	5014
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	68	229	283	404	600	715.843/ 470.258	891	1102	1272	1574	2000	2347	5309
Condensate Yield ((bbl/Mmcfg)	7.60	19.21	22.58	29.61	40.00	44.286/21.197	54.04	63.51	70.85	83.31	99.98	112.90	210.20

Pool Size Distribution Statistics from *POOLS* (1,000 BOE):	μ (mu)= 10.2290800	σ^2 (sigma squared)= 2.02456443	Random Number Generator Seed= 646005

BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	1
Probability Any Pool is 100% Oil	0	Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.25
Probability Any Pool is 100% Gas	0		

Table 3. Input data for Beaufort Sea play 11, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province: Beaufort	**Play Number, Name:**	11, Brookian Unstructured Western Turbidite
Assessor(s): Johnson/Scherr	**Play UAI:**	AAAAABAS
Date: 20-Oct-05		

For each component, a *quantitative* probability of success (i.e., between zero and one, where zero indicates no confidence and one indicates absolute certainty) based on consideration of the *qualitative* assessment of **ALL** elements within the component was assigned. This is the assessment of the probability that the minimum geologic parameter assumptions have been met or exceeded.

		Play Chance Factors	**Averge Conditional Prospect Chance[1]**
1. Hydrocarbon Fill component (1a * 1b * 1c)	**1**	*1.0000*	*0.8000*
a. Presence of a Quality, Effective, Mature Source Rock			
Probability of efficient source rock in terms of the existence of sufficient volume of mature source rock of adequate quality located in the drainage area of the reservoirs.	1a	1.00	1.00
b. Effective Expulsion and Migration			
Probability of effective expulsion and migration of hydrocarbons from the source rock to the reservoirs.	1b	1.00	0.80
c. Preservation			
Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	1.00
2. Reservoir component (2a * 2b)	**2**	*1.0000*	*0.6000*
a. Presence of reservoir facies			
Probability of presence of reservoir facies with a minimum net thickness and net/gross ratio (as specified in the resource assessment).	2a	1.00	0.60
b. Reservoir quality			
Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and permeability (as specified in the resource assessment).	2b	1.00	1.00
3. Trap component (3a * 3b)	**3**	*0.8000*	*1.0000*
a. Presence of trap			
Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	0.80	1.00
b. Effective seal mechanism			
Probability of effective seal mechanism for the trap.	3b	1.00	1.00

Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)	**0.8000**	
(1 * 2 * 3) *Product of All Subjective Play Chance Factors*		

Average Conditional Prospect Chance[1]		**0.4800**
(1 * 2 * 3) *Product of All Subjective Conditional Prospect Chance Factors*		
[1] **Assumes that the Play exists (where all play chance factors = 1.0)**		
Must be consistent with play chance and prospect distribution -- See discussion on Page 3 of Guide		

Exploration Chance	**0.3840**
(Product of Overall Play Chance and Average Conditional Prospect Chance)	

Comments: *See guidance document for explanation of the Risk Analysis Form*

Table 4. Risk model for Beaufort Sea play 11, 2006 assessment.

GRASP - Geologic and Economic Resource Assessment Model - PSUM Module Results
Minerals Management Service - Alaska OCS Region
GRASP Model Version: 8.29.2005)
Computes the Geologic Resource Potential of the Play

Play UAI: AAAAABAS			**Play No.**		**11**		
World	Level	-	World	Level	Resources	
Country	Level	-	UNITED	STATES	OF	AMERICA
Region	Level	-	MMS	-	ALASKA	REGION
Basin	Level	-	**BEAUFORT**	**SHELF**		
Play	**Level**	**-**	**Play**		**11 Brookian**	**Unstructured**
Geologist	Peter	Johnson			**Western**	**Turbidite**
Remarks	Play	11	2005 assessment			
Run Date & Time:	Date	19-Sep-05 Time		13:49:18		

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	218,390	310,260
Oil (Mbo)	151,120	220,300
Condensate (Mbc)	9,633	16,265
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	216,870	330,260
Solution Gas (Mmcfg)	107,100	181,290

    10000 (Number of Trials in Sample)
    0.7908 (MPhc [Probability] of First Occurrence of Non-Zero Resource)
    Windowing Feature: used

Empirical Probability Distributions of the Products

Greater Than Percentage	BOE (Mboe)	Oil (Mbo)	Condensate (Mbc)	Free (Gas Cap & Nonassociated) Gas (Mmcfg)	Solution Gas (Mmcfg)
100	0	0	0	0	0
99.99	0	0	0	0	0
99	0	0	0	0	0
95	0	0	0	0	0
90	0	0	0	0	0
85	0	0	0	0	0
80	0	0	0	0	0
75	21,929	14,742	1,016	24,793	9,887
70	42,917	29,497	1,947	45,402	19,076
65	63,594	44,397	2,508	62,651	31,144
60	82,125	56,378	3,726	86,518	37,241
55	101,450	69,836	4,466	104,260	48,293
50	122,370	84,831	5,441	123,510	56,862
45	146,430	101,690	6,172	147,230	69,519
40	172,800	119,690	7,530	172,600	83,612
35	203,350	141,610	8,749	196,510	101,330
30	241,440	165,760	10,391	249,510	117,410
25	286,150	196,140	12,318	286,920	149,690
20	340,650	239,200	14,768	326,690	160,470
15	417,900	289,190	18,238	421,110	199,730
10	537,930	371,720	22,688	526,810	279,810
8	607,100	421,210	27,143	602,410	289,710
6	707,840	492,450	29,129	674,670	372,090
5	776,680	536,260	33,135	778,370	386,560
4	884,330	603,120	42,664	924,300	416,300
2	1,158,200	802,940	54,968	1,122,600	565,040
1	1,477,200	1,020,900	67,621	1,469,100	715,420
0.1	2,896,300	2,170,100	33,475	1,269,200	2,624,300
0.01	3,404,400	2,292,600	137,680	3,246,200	2,228,400
0.001	5,347,000	3,843,200	181,440	3,379,000	4,052,300

Table 5. Assessment results by commodity for Beaufort Sea play 11, 2006 assessment.

Basin: BEAUFORT SHELF
Play 11 - Brookian Unstructured Western Turbidite
UAI Key: AAAAABAS

Model Simulation "Pools" Reported by "Fieldsize.out" *GRASP* Module

	Classification and Size			Pool Count Statistics			Pool Types Count			Mixed Pool Range		Oil Pool Range		Gas Pool Range		Total Pool Range		Pool Resource Statistics (MMBOE)			
Class	Min (MMBOE)	Max (MMBOE)	Pool Count	Percentage	Trial Average	Trials w/Pool Avg	Mixed Pool	Oil Pool	Gas Pool	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Total Resource	Average Resource
1	0.0312	0.0625	2	0.006787	0.0002	0.000253	2	0	0	1	1	0	0	0	0	1	1	0.058667	0.061954	0.120621	60.310282
2	0.0625	0.125	8	0.027147	0.0008	0.001012	8	0	0	1	1	0	0	0	0	1	1	0.083422	0.116025	0.819815	102.476887
3	0.125	0.25	49	0.166276	0.0049	0.006195	49	0	0	1	1	0	0	0	0	1	1	0.125614	0.246215	9.143597	186.604023
4	0.25	0.5	121	0.410601	0.0121	0.015299	121	0	0	1	2	0	0	0	0	1	2	0.252750	0.499441	46.236057	382.116169
5	0.5	1	251	0.851743	0.0251	0.031736	251	0	0	1	2	0	0	0	0	1	2	0.501047	0.998665	186.470019	742.908418
6	1	2	577	1.95799	0.0577	0.072955	577	0	0	1	2	0	0	0	0	1	2	1.008875	1.999038	868.425079	1.505069
7	2	4	1397	4.740575	0.1397	0.176634	1397	0	0	1	3	0	0	0	0	1	3	2.001027	3.997903	4191.501000	3.000359
8	4	8	2916	9.895144	0.2916	0.368694	2916	0	0	1	4	0	0	0	0	1	4	4.002099	7.999801	17459.037000	5.987324
9	8	16	4647	15.769114	0.4647	0.587558	4647	0	0	1	4	0	0	0	0	1	4	8.002460	15.994928	54901.631000	11.814425
10	16	32	5886	19.973532	0.5886	0.744215	5886	0	0	1	5	0	0	0	0	1	5	16.003026	31.997586	136310.923000	23.158499
11	32	64	5456	18.514372	0.5456	0.689847	5456	0	0	1	5	0	0	0	0	1	5	32.000270	63.997678	249885.600000	45.800148
12	64	128	4129	14.011334	0.4129	0.522063	4129	0	0	1	5	0	0	0	0	1	5	64.010037	127.989305	370003.439000	89.610909
13	128	256	2307	7.828566	0.2307	0.291693	2307	0	0	1	4	0	0	0	0	1	4	128.025279	255.896791	409796.573000	177.631805
14	256	512	1123	3.810784	0.1123	0.14199	1123	0	0	1	3	0	0	0	0	1	3	256.169295	510.393885	398501.576000	354.854462
15	512	1024	463	1.571143	0.0463	0.058541	463	0	0	1	2	0	0	0	0	1	2	512.472241	1021.062000	331830.630000	716.696838
16	1024	2048	118	0.400421	0.0118	0.01492	118	0	0	1	2	0	0	0	0	1	2	1025.746000	2030.997000	158784.570000	1.345632
17	2048	4096	19	0.064475	0.0019	0.002402	19	0	0	1	1	0	0	0	0	1	1	2151.253000	3303.819000	51170.484000	2.693183
18	4096	8192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
19	8192	16384	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
20	16384	32768	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
21	32768	65536	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
22	65536	131072	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
23	131072	262144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
24	262144	524288	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
25	524288	1048576	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
Not Classified			0	0	0	0	Below Class 0	0	0									Below Class 0.000000	0.000000	0.000000	0.000000
	Totals		29469	100.000015	2.9469	3.726008	Above Class 0	0	0									Above Class 0.000000	0.000000	0.000000	0.000000

Min and Max refer to numbers of pools of the relevant size class that occur within any single trial in the simulation.

Min and Max refer to aggregate resources of the relevant size class that occur within any single trial in the simulation.

Number of Pools not Classified: 0
Number of Pools below Class 1: 0
Number of Trials with Pools: 7909

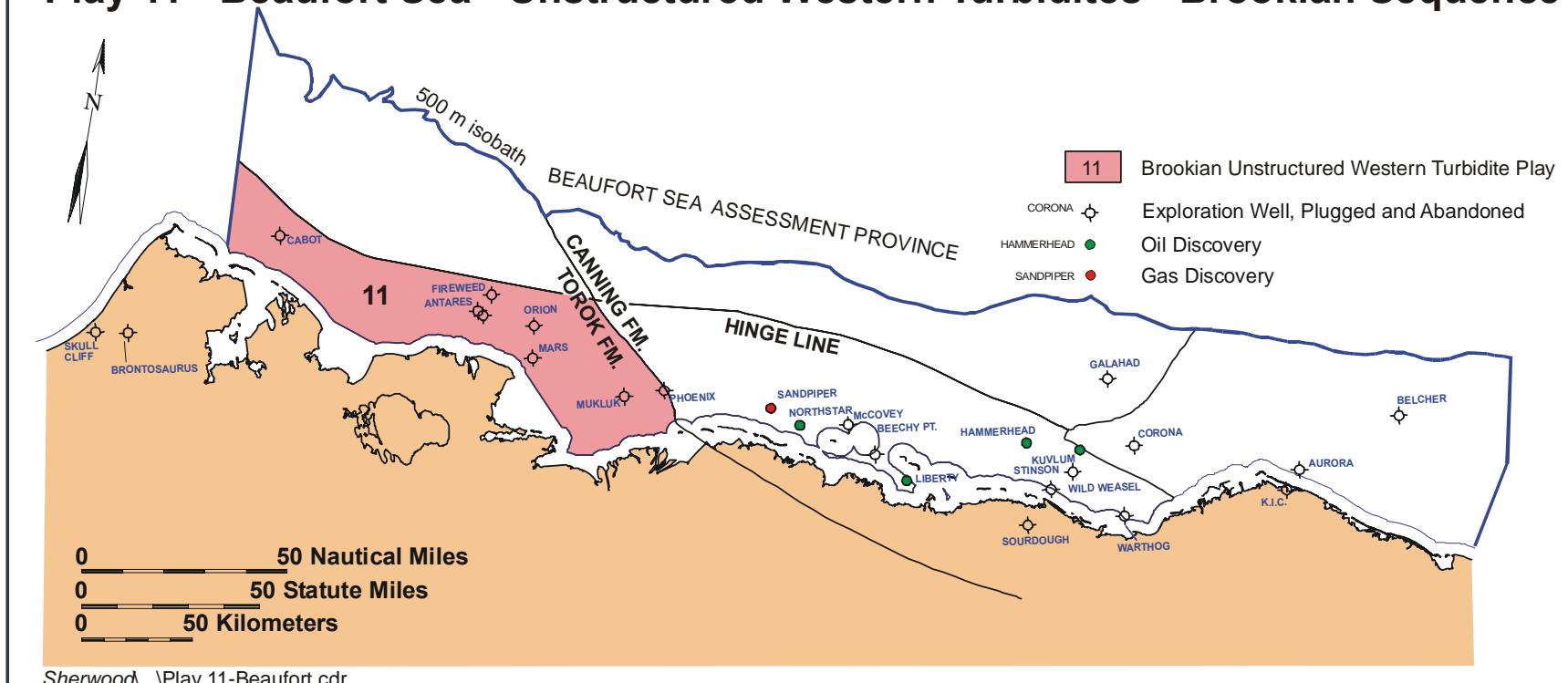**Table 6**. Statistics for simulation pools created in computer sampling run for Beaufort Sea play 11, 2006 assessment.

Figure 1. Map location of Beaufort Sea play 11, 2006 assessment.